https://dergipark.org.tr/tr/pub/ijhmt Doi Number: 10.31201/ijhmt.1123824

Int Journal of Health Manag. and Tourism 2022, 7(2), 200-216

JHMT Editorial

International Journal of Health Management and Tourism

DESIRABILITY OPTIMIZATION BASED ON THE POISSON REGRESSION MODEL: ESTIMATION OF THE OPTIMUM DENTAL WORKFORCE PLANNING

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Received:31.05.2022
Accepted: 16.07.2022
Research Article

Abstract

Aim: This study aims to estimate the optimum number of dentists needed by determining the social and economic variables that affect the dental workforce planning in Turkey.

Methods: A desirability optimization model based on the Poisson regression model was used to evaluate the importance of the variables of this study and to calculate the optimum values of the variables. The data used in the study cover the years 1960-2018. Population (x_p), gross domestic product per capita (x_{pc}), life expectancy (x_{le}), and literacy rate (x_{lr}) were considered as input variables affecting the dental workforce (y_d).

Results: The values of deviance R^2, adjusted R^2, and Akaike Information Criterion (AIC) were computed as 0.9941, 0.9941, and 960.11, respectively, which confirm the validity of the Poisson statistical test. The dual mechanism reliability was obtained by adhering to the 'what-if' perspective and desirability values of the top-ten optimum values of the dental workforce.

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Conclusion: The results of the study show that social and economic determinants play an important role in the estimated dental workforce planning assessment required for oral and dental health in Turkey.
Keywords: Dental workforce planning, Factors, Poisson regression, Desirability optimization, Estimation

INTRODUCTION

This study is not directly related to oral and dental diseases but is a study for the dental workforce in terms of healthcare management. The most critical issue in healthcare management is determining the number of employments to utilize the healthcare resources efficiently and allocate them to health departments (Atalan & Donmez, 2020). Health resources are defined as physical factors such as beds, triage areas, medical equipment, etc., and human factors such as doctors, nurses, assistants, technicians, civil servants, etc. (Atalan & Dönmez, 2020; Mihaylova et al., 2011). In this study, dentists, defined as a different healthcare resource employed in Turkey, were considered. The dental workforce differs from other healthcare resources because they are employed in private clinics rather than working in traditional hospitals in the Turkish healthcare system (Atalan, 2018). Very few studies on healthcare management contain information about the dental workforce (Vernazza et al., 2021). Most scientific research on dentistry is about dental and oral healthcare (Watt et al., 2020). In this study, an optimum estimation study was carried out by determining the factors affecting the dental workforce in public institutions (Atalan, 2021a).

A study has only examined the impact of demographics features of people on the dental workforce at a national level (Surdu et al., 2021). Another study provided information on factors influencing oral health workforce planning and management in developing countries (DCs) (Knevel et al., 2017). Gayawan examined the impact of the UK on the planning of the oral health workforce after the Brexit process (Eaton, 2020). The effects of many factors, such as the social and demographic factors of a country, on the dental workforce in the healthcare systems were discussed in detail in this study. Studies show that healthcare management decisions are affected by various determinants such as individual, population, economic and educational factors (Gayawan, 2014).

This study investigated the factors affecting the dental workforce in Turkey. The analysis includes data for dependent and independent variables over 59 years. Population, GDP PC ($), life expectancy, and literacy rate factors affecting dental employment were defined as input factors for the derivation of estimation data. Detailed information about the aims, methods and used factors of the studies on the dental workforce is given in Table 1.

Table 1. Studies on the dental workforce

Purpose of the Study	Factors	Methods	Ref.
Compare the frequency and duration of career breaks taken by the dental surgeons and evaluate the impact of these and changes in working hours on human resource planning	Age, the proportion of hygienists, the duration of career breaks, GDPs of dental surgeons	Questionnaire survey, statistical analysis	(Newton et al., 2001)
Forecasting the supply and demand of dental operations in the UK	Staff type, staff cost, treatment hours, treatment type,	Operational research (OR) techniques-linear programming	(Harper et al., 2013)
Establishing a forecasting model of demand and supply for dentists for workforce planning in dentistry	The age structure of the population, the dentate and edentulous subpopulations of adults,	Forecasting models, statistical analysis	(Try, 2000)
Literature review on factors influencing oral health workforce planning and management in developing countries (DCs)	Lack of data, the restorative and preventive care, the number of dental schools, the dentistry students, privatization of dental care services, skill mix, the scope of practice, workforce management	Literature review	(Knevel et al., 2017)
Identifying data sources from countries concerned with the selection of oral health indicators in a sample of FDI member countries;	Children oral health care, Behaviors and coverage, Oral health economics, Oral health equality of life	A cross-sectional survey- Mann–Whitney U-tests, statistical analysis	(Yamalik et al., 2013)
Develop and operationalize a workforce planning simulation tool based on oral health needs	Gender, age, number of natural teeth, the problem with food/pain, level of service, type of service, frequency of service	Simulation models	(Ahern et al., 2019)

Identify trends in the dental workforce in Oman from 1990 to the present and compare the dental workforce with medical counterparts in Oman and other countries, and assess the future dental workforce in Oman	Dentist workforce, dentist-to-population ratios	Basic integrated model, statistical analysis	(Gallagher et al., 2015)
estimating patient and service ratios for oral health therapists (OHTs), dental hygienists (DHs), and dental therapists (DTs)	Age, sector of practice, practice type, length of service, number of dentists, % of child patients, locations,	self-report questionnaire, statistical analysis	(Teusner et al., 2016)
Identifying factors affecting the dental workforce and predicting the optimum dentist	Economic, population, literacy rate, the life of expectancy, dentist workforce	Poisson Regression, Desirability Optimization	This Study

FDI: World Dental Federation

The present study used the Poisson regression analysis method for response variables with integer values to estimate the optimum dentist workforce. The Poisson model was suitable for the dataset to analyze the effects of controlling and having different types of independent variables on their common response variable. The Poisson model, which has more than one variable, has been preferred by researchers with a wide range of applications in many areas where data sets are matched, resulting in the actual results of the research. The effect of independent variables on dependent variables was revealed by using this statistical analysis for dental health management in the present study. Saman et al. used Poisson regression modelling and geospatial analysis to assess the geographic distribution of dentists in Kentucky to identify the socioeconomic relationships of practice location and predict the future availability of dentists (Saman et al., 2010). The most important feature that distinguishes this study from other studies is that the Poisson regression model is not directly related to a medical issue but health management and informatics (Atalan, 2020). The paper proposes that the Poisson regression model perspective should be used to contribute to the development of data analysis in healthcare management. There is no specific poisson regression model for calculating the predictive values of the data. Input and output variables ran in the Poisson regression model were used to obtain estimated data.

The Poisson regression analysis is commonly used in studies directly related to the human factor. A study used the Australian health survey and the US National Medical Expenditure Survey data, including the number of the physician or specialist consultations, hospital admissions, etc., using the bivariate generalized Poisson regression model (BGPR) (Zamani et al., 2016). In another study, the Poisson regression model was preferred using data from the 2008 Nigeria Demographic and Health Survey to statistically analyze the individual and population-level determinants of antenatal care use (Gayawan, 2014). Islam and Chowdhury have demonstrated procedures for estimating and testing bivariate Poisson regression models using Health and Retirement Study data for the number of health conditions and health services (Islam & Chowdhury, 2017).

The Poisson regression model was preferred to determine whether the data obtained from research conducted in Pittsburg Veterans Affairs Hospital had the same incline in all departments before the intervention and whether the instant effect of the intervention was the same in all divisions (GEBSKI et al., 2012). In another study, Poisson regression analysis analyzed independent variables such as age, race, gender, occupation, workplace, and working time that affected the dependent variable, blood and body fluids (BBF) (Dement et al., 2004). Alamgir and Yu used a Poisson regression modelling application with one year of data to investigate occupational injury epidemiology among cleaners working in healthcare locations in British Columbia, Canada (Alamgir & Yu, 2008). The main reason for using Poisson statistical models in health is that the data belonging to the dependent or independent variables and the data obtained as a result of the analysis are integers as a result of the examination of many studies.

This study is motivated to use Poisson regression analysis to identify factors affecting the dental workforce in Turkey and demonstrate to predict the number of dentists employed in healthcare management. This study consists of five main parts. A literature review about the research subject and the methods used were included in the first part of the study. The mathematical explanation of Poisson regression analysis and desirability equations was discussed in the paper's second part. Detailed information about the study data was also provided in this section. The numerical results of the methods used were examined in the third part of the study. Some limitations constraining the subject of the study were discussed in the fourth section. The consequences of the emergence of this study and the results of the recommendations were involved in the last section of the study.

1. RESEARCH METHODOLOGY

The method of Poisson regression analysis was taken into account to analyze the data in this study. Poisson regression analysis was preferred since the data used were integer values. The preference of the Poisson distribution in studies involving human factors is that it is suitable for the data to be obtained. The regression model, which is generally defined as the log-linear model, is used by researchers as the Poisson regression model. Poisson statistical analysis involves estimating a response variable using one or more input variables. Ethics committee approval is not required as the data used is publicly available and references the data used for this study

This study defined the dependent variable as the number of dentists employed in Turkey between 1960 and 2018. Figure 1 shows the number of dentists employed during the selected period. The number of dentists considered includes only those employed in government institutions. The average of the 59-year data was calculated as 11373, while the number of dentists employed in 2018 was 30615. The number of dentists employed per 1000 people was computed as 0.429 for 2018.

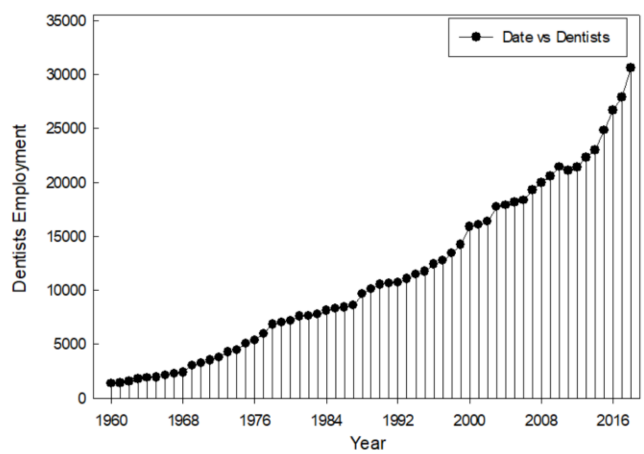


Figure 1. The dentists employed between 1960-2018

Country population, gross domestic product per capita (GDP PC), life expectancy, and literacy rate (considered as an education factor) that affected the dependent variable were defined as independent or input variables. These factors were preferred to establish the link between the increase in the rate of patients applying to dental clinics and the number of employed dentists. In addition to being directly related to the rise in the country's population and the dental workforce, the desire of people to live for a long time also plays an essential role in this relationship. Due to little or no government support for dental treatment in most countries, people have to pay for these treatments out of pocket. In this case, we have taken this factor into account in this study to question the link between people's income rate and dental treatment. With the last input parameter of the study, people's literacy rate data were taken to analyze the importance that educated people attach to dental treatment. There are two cases in the data used for this factor. The data used belong to the literacy rates of people aged 15 and over. The other case consists of annual data between 2004 and 2018 and five-year data between 1960 and 2004. The data for the years in which literacy rates could not be reached were formed by taking the average values of the differences between the two years. Types, definitions and notations information of dependent and independent variables are provided in Table 2.

Table 2. Detailed Information About Variables

Variables	Types	Definition	Code
Dentists Workforce	Dependent	Number of dentists employed between 1960 and 2018, No distinction was made between men and women in the number of employed doctors. It is considered as a single data, integer, person	y_d
Population	Independent	Country population from 1964 to 2018, integer, person	x_p
Life Expectancy	Independent	Life expectancy at birth. From birth, life expectancy in humans is expressed in years and how long a newborn can expect to live on average. The unit of this variable is taken as the year.	x_{le}
GDP PC	Independent	This variable is considered the gross national product data were covering the years 1960 to 2018. The unit of this variable is USA currency, $.	x_{pc}
Literacy Rate	Independent	The data used belong to the literacy rates of people aged 15 and over. The literacy rate covers all education levels. The unit of this variable is taken as the percentage of the population.	x_{lr}

The following equations express poisson regression models: dependent, y_{ijkl} (with the x_p i; x_{pc}, j; x_{le}, k; x_{lr}, l) and independent factors, $\mu_{ijkl}, v_{ijk}, s_{ij}, t_m$ (Gayawan, 2014):

$$y_{ijklm}|\gamma, \mu_{ijk}, v_{ij}, s_i \sim Poisson\ (\mu_{ijkl}) \tag{1}$$

$$\log(\mu_{ijkl}) = \eta_{ijkl} = x_{ijkl}\gamma + \mu_{ijk} + v_{ij} + s_i \tag{2}$$

where x_{ijkl} represents the corresponding vector value of the covariates, and γ denotes the coefficient of the independent variables. μ_{ijkl} represents the dependent variable and the average number of dentists employed or the dental workforce in the year i. η_{ijkl} characterizes the logarithmic Poisson regression model. The Poisson analysis coefficient estimates consider how the average number, y, changes after one year in the number of dentists employed. Nevertheless, instead of examining the difference in the average number in the data set, it considers the log of the average number in the data set with Poisson regression. It then converts it back to the original units. The comparison of the two models, for a certain period (i) and after increasing the other period by 1 ($i+1$), is done as follows (Roback & Legler, 2021):

$$\begin{gathered}\log(y_{ijkl}) = x_{ijkl}\gamma + \mu_{ijk} + v_{ij} + s_i \\ \log(y_{(i+1)jkl}) = (x+1)\gamma \\ \log(y_{(i+1)jkl}) - \log(y_{ijkl}) = \gamma \\ \log\left(\frac{y_{(i+1)jkl}}{y_{ijkl}}\right) = \gamma \\ \frac{y_{(i+1)jkl}}{y_{ijkl}} = e^{\gamma}\end{gathered} \tag{3}$$

Estimating the number of dentists employed was provided using the correlation coefficient (R). The equations used for performance measurement are given below:

$$R = \sum_{i=1}^{n}\left[\frac{\tilde{y}_i - y_i}{y_i - \bar{y}_i}\right]^2 \tag{4}$$

where y_i, $\bar{y}_i$, and $\tilde{y}_i$ represent the actual value in the data set, the average value of the data set, and the predictive values generated by the Poisson regression model, respectively. n is the number of samples in a dataset. The value of R takes a number between 0.00 and 1.00. Minitab 18.1 software was utilized for descriptive statistics and the optimum Poisson regression method for data analysis.

The present study aims to calculate the optimum value of the dentist workforce required for Turkey by calculating the optimum values of the factors affecting the dental workforce, defined as decision variables. The desirability degrees of the created algorithm were taken into account while calculating the optimum values (Ayaz Atalan et al., 2020). The desirability value represents the validity of the results of an optimization model and that the results reach the optimum level.

There are three cases for the degree of desirability, and the following equations are considered (Ramanujam et al., 2014):

$$d_i = \begin{cases} \left[\dfrac{\tilde{y}_i - y_{min}}{T - y_{min}}\right]^s, & y_{min} \le \tilde{y}_i \le T, \quad s \ge 0 \\ \left[\dfrac{\tilde{y}_i - y_{max}}{T - y_{max}}\right]^t, & T \le \tilde{y}_i \le y_{max}, \quad t \ge 0 \end{cases} \tag{5}$$

$$d_i = \begin{cases} 1, & \\ \left[\dfrac{\tilde{y}_i - y_{max}}{y_{min} - y_{max}}\right]^r, & y_{min} \le \tilde{y}_i \le y_{max}, \quad r \ge 0 \end{cases} \tag{6}$$

$$d_i = \begin{cases} 0, & \tilde{y}_i \le y_{min} \\ \left[\dfrac{\tilde{y}_i - y_{min}}{T - y_{min}}\right]^r, & y_{min} \le \tilde{y}_i \le y_{max}, \quad r \ge 0 \\ 1, & \tilde{y}_i \ge y_{min} \end{cases} \tag{7}$$

where, d_i is defined as the desirability value of $\tilde{y}_i$. y_{min} represents the lower acceptable limit of $\tilde{y}_i$ and y_{max} the allowable upper limit of $\tilde{y}_i$, and $s, t, and\ r$ symbolize the weights measured. The value of $\tilde{y}_i$is used to reach a specific target T (optimal value) (Jenarthanan & Jeyapaul, 2018). The following formula is used to calculate the estimated value of the response based on the optimum parameter level and validate the results:

$$d_i = (d_1^{w_1} d_2^{w_2} d_3^{w_3} \dots\ d_n^{w_n})^{1/w} \tag{8}$$

where, $w_1, w_2, w_3, \dots, w_n$ are the weight of the desirability approach in $\tilde{y}_i$. w is the sum of the $w_1, w_2, w_3, \dots, w_n$.

2. FINDINGS

The study data were obtained from publicly accessible data by the Turkey Statistical Institution (TUIK) (TUIK, 2021). *A* Poisson statistical analysis was performed to examine the relationship between four different input variables and the employed dentist *f*or the first phase of this study. The data of the dental workforce, which is the dependent variable, were analyzed with the

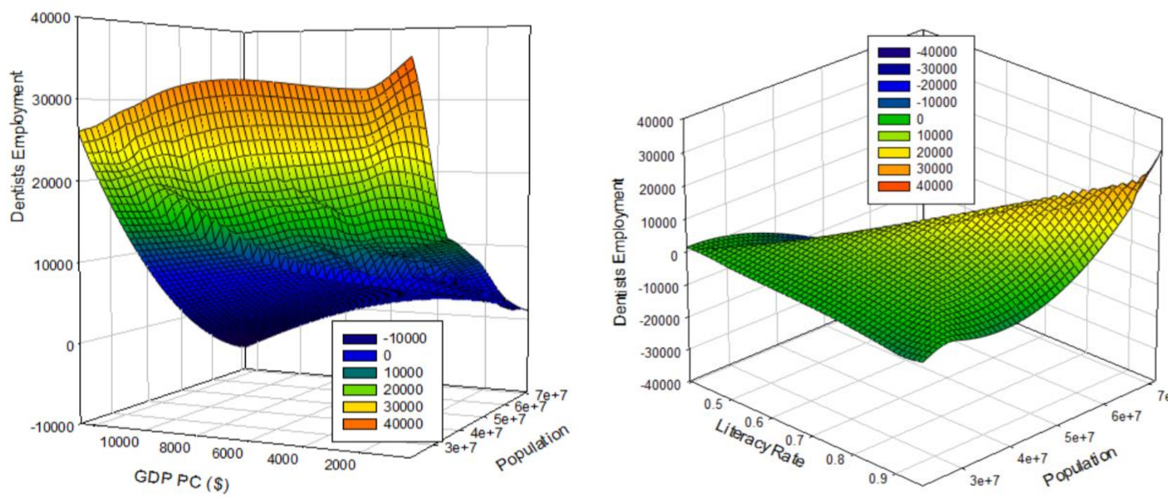
Kolmogorov-Smirnov normality test to verify that the data were normally distributed (*p-value=0.00553*, *test value=0.114*, null hypothesis: the data follow a normal distribution, alternative hypothesis: the data do not follow a normal distribution, interpret: *reject the null hypothesis*). The Pearson and Spearman rho correlation tests analyses were performed to measure the correlation values between dependent and independent variables, and the correlation values are shown in Table 3. Correlation values between variables vary between -1 and +1. The closer the correlation value between two variables is to -1 or +1, is interpreted as the vital link between the variables. The values among the variables selected for this study are very high and show a positive trend, approaching +1 (Atalan, 2021b). The lowest correlation values were calculated at 0.821 by the Spearman-rho test, which is valid for x_{pc} and x_{lr} variables. The Pearson correlation test analyzed the lowest value among the correlation values was analyzed at 0.862 by the Pearson correlation test, which is valid for x_{pc} and x_{le} variables. The highest correlation value was calculated as 0.992 with the Pearson correlation test, and this value was between x_p-x_{le} and x_{lr}-x_{le}. The highest correlation value was computed as 0.998 with the Spearman-rho correlation test. This value was between x_p-y_d, x_{le}-y_d, x_{le}-x_p, and x_{lr}-x_{le}.

Table 3. Correlation Values of Dependent and Independent Variables

Variables	Test Type	y_d	x_P	x_{le}	x_{Pc}
x_P	Pearson	0.984	------	------	------
	Spearman-rho	0.998	------	------	------
x_{le}	Pearson	0.961	0.992	------	------
	Spearman-rho	0.998	0.998	------	------
x_{Pc}	Pearson	0.927	0.907	0.862	------
	Spearman-rho	0.976	0.976	0.976	
x_{lr}	Pearson	0.943	0.978	0.992	0.911
	Spearman-rho	0.994	0.997	0.997	0.821

The dataset using the Poisson regression model of the dental workforce was created to evaluate the effect of the independent variables on the response factor. The Poisson statistical analysis was performed to measure the effect of independent variables on the dependent variable. The most important reason for choosing this analysis is that the data used and obtained are integers. The values of deviance R^2, adjusted R^2, and Akaike Information Criterion (AIC) were computed as 0.9941, 0.9941, and 960.11, respectively, which confirm the validity of the Poisson statistical test. We determined that the data used was appropriate in terms of the method applied, and the results obtained were consistent since the model's R^2 values were high, and the better the model fits the data based on the AIC value. Poisson statistical analysis data are analyzed whether the independent variables are statistically effective on the dependent variable. Four independent variables substantially affect the dependent variable. x_p, x_{le}, x_{pc}, and x_{lr} were measured with values of 0.001, 0.014, 0.001, and 0.003, respectively, which were statistically effective on the dental workforce ($p - value \leq 0.05$).

The effect of the independent variables on the interactively dependent variable was discussed in detail. The response surface fitted mean plots were expressed in Figure 2 to understand whether these factors affect positively or negatively. In the Poisson statistical analysis, according to the figures showing the effect of the independent variables on the dependent variables, the values of the independent variables show a non-linear trend as the values of x_{pc} and x_p variables increase, and the number of employed dentists increases. However, due to the interaction between the x_p and x_{le}, the effects on the number of dentists employed seem to fluctuate. There is an interesting correlation between x_{pc} and x_{lr} variables. A decrease in the number of employed dentists is observed as the value of the x_{lr} increases after reaching a certain value of x_{pc}. All of the dependent variables considered adequately described the change in the number of dentists employed in Turkey in the Poisson model combining their effects.



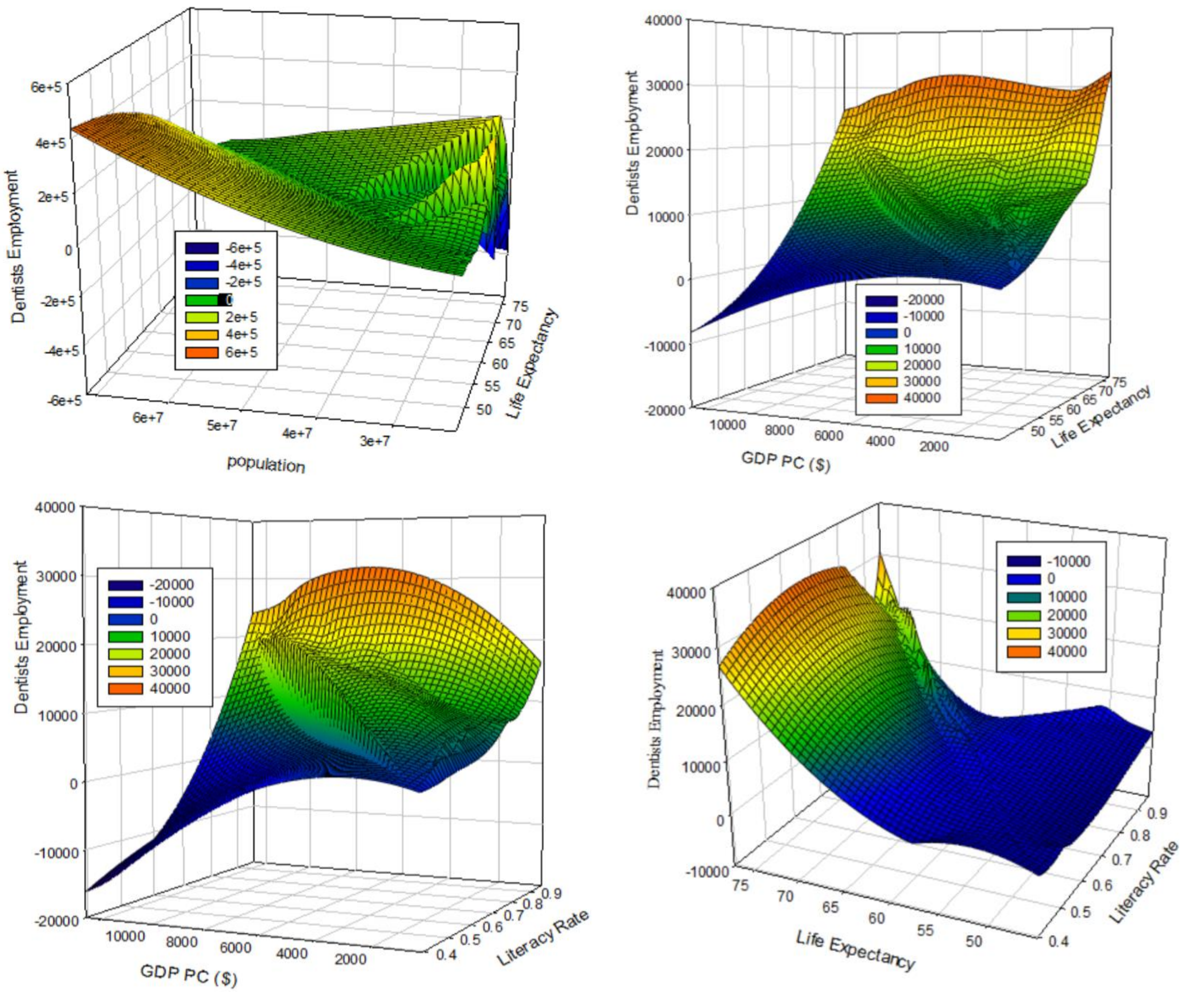


Figure 2. Effects of binary interactions of factors on the y_d

[the relationship of a) x_{pc}-x_p b) x_{lr}-x_p, c) x_p-x_{le}, d) x_{pc}-x_{le}, d) x_{pc}-x_{lr}, e) x_{lr}-x_{le}]

Optimum values according to the degree of desirability are shown in Table 4. The top ten optimum results were evaluated according to the degree of desirability. Each desirability series is also the value included in the optimum solution set. The values of the objective function were calculated according to the values of the decision variables. These results were obtained from the what-if perspective.

Table 4. Optimum values according to the degree of desirability

Optimization Models	Desirability d_i	Objective functions (y_i)	Decision Variables (what if-value)			
			Input (x_P)	Input (x_{le})	Input (x_{pc})	Input (x_{lr})
Solution 1	1.00000	51627.7	21951215	77.3100	---	0.9640
Solution 2	1.00000	31252.5	21951215	77.3100	12614.0	0.9640
Solution 3	1.00000	43058.8	71321399	77.3100	---	0.9640
Solution 4	1.00000	35566.9	71321399	77.3100	---	0.3951
Solution 5	1.00000	42645.0	21951215	77.3100	---	0.3951
Solution 6	1.00000	31258.9	21951215	77.3100	12609.1	0.9640
Solution 7	1.00000	30615.0	21951215	72.1735	---	0.9640
Solution 8	0.99999	30614.6	71321399	73.9573	---	0.9640
Solution 9	0.99998	30614.5	71321398	73.9573	---	0.9640
Solution 10	0.99998	30614.3	71321397	77.3100	8695.30	0.964

--- Absence of values in the feasible solution set but not significantly supporting the optimum result

Desirability differs according to the objective function value of the decision variables according to the optimum values. According to solution 1, the population of the country should be approximately 22 million and the x_{le} and x_{lr} should be at the maximum level for the current workforce of occupational dentists. A dentist is assigned to around 426 patients based on solution 1. Based on the 2018 population value, at least 167744 dentists should be employed. However, according to 2018 data, a dentist is appointed to treat 1381 people. From another point of view, the fluctuation in the number of dental workforces is also inversely proportional to the x_{pc} factor. It is seen that there will be a decrease in dentist power with the increase in x_{pc} value, but there is a decrease in x_p with the same trend. For this result, the optimum x_{pc} value could not be obtained. In addition, for the desirability optimization model, the degree of desirability decreases after the 7th iteration of the model.

Since an objective function has more than one decision variable, it is inevitable to obtain the results obtained from the what-if perspective. In the same way, the method developed according to the values of the decision variables is used to get the optimum value of the dental workforce. This study offers a solution to the resource management problem in dental workforce management with the desirability optimization based on the Poisson regression model. The optimum level of the dental workforce is directly related to the social and economic infrastructure of a country. A country's population, gross domestic per capita, life expectancy, and literacy rate should be at a certain level for optimum dentist needs. As a result, the current values of the indicators and the optimum dentist workforce value do not match the Turkish healthcare system.

3. CONCLUSIONS AND RECOMMENDATIONS

The traditional statistical analysis, Poisson, a popular topic today, was integrated into this study. The factors affecting the decision of the dental workforce in Turkey were analyzed with the Poisson statistical analysis method to estimate the number of dentists employed. Pearson and spearman rho correlation analysis calculated the correlation values between the factors. The strong correlation values were estimated between dependent and independent variables. Poisson statistical analysis model has high R^2 values and proves that the data used is in harmony with the method. The present study shows the effects of x_p, x_{pc}, x_{le}, and x_{lr} on the y_d were very significant. In addition, dual mechanism reliability was achieved by adhering to the what-if perspective and desirability values to determine the optimum values of the objective function in this study.

To conclude, the Poisson regression model provides the opportunity to know the problems that may occur by obtaining predictive data and sensitivity analyses in many areas. The potential of the Poisson regression model in overcoming the complexity of various data and the difficulties encountered in healthcare management has been revealed in this study. The most crucial reason for consistent data in healthcare management is the human factor. To minimize the cost of human resources in healthcare, the Poisson regression model models must be needed to overcome the data of this complex system. This paper showed the method that allows the Poisson regression model to be developed for predictive data to enable more data-driven health informatics and management solutions. The implications of this research are that health system management will become more dependent on the Poisson regression model of complex data such as human resources, health economics, patient rights, patient and health professional satisfaction, etc.

This study has some limitations. The analysis is limited to four input factors, eliminating factors that cannot accommodate long-term data. Therefore, the effects of variables with other demographic characteristics on the dental workforce could not be analyzed. The previous workforce size may well be driven to a greater degree by supply-side factors such as the availability of dental training courses places, the appeal of the career, including pay, and relative ease and amount of immigration of dentists into the country. A second limitation is the x_lr data selected among the independent parameters to reflect the education level in the country. Otherwise, this study does not directly include the education level factor when there is no long-term data on education level. The data obtained in this study were taken into account by four independent factors. Another limitation is that the dental workforce is limited only to those working in government-supported institutions. Since there is no official data on the dental workforce in private dental clinics, they were not included in the study.

Healthcare expenditure rates in countries are increasing day by day. One of the most significant shares in health expenditures is health resources. Using alternative resource allocation techniques in dental health care, policymakers can provide more information about the economic impact to decision-makers (Vernazza et al., 2021). Inefficient resource management negatively affects health systems in terms of cost and time (Hung et al., 2019). For this reason, it is inevitable to use the Poisson regression model, which is one of the most up-to-date methods of today. This study offers a solution to the resource management problem in health management with the Poisson statistical analysis method.

Acknowledgement

This research received no specific grant from any funding agency in public, commercial or not-for-profit sectors.

Conflict Of Interest

The author declares that there is no conflict of interest.

Funding

The author(s) received no financial support for this study's research and/or authorship.

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